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(54) Conductive fabric sensor system

Sensorsystem mit einem leitfähigen Gewebe

Système de détection à tissu conducteur

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Description

Field of the Invention

[0001] The present invention relates generally to sensor systems using conductive fabric, and more specifically to conductive fabric sensor systems that can operate either as a switch or weight sensor.

Background of the Invention

[0002] There are many applications for weight sensors which can be used to facilitate a triggering system or attenuate a triggering system that is made operative automatically upon the occurrence of certain events. One such circumstance is the deployment of safety airbags from a vehicle interior. It has been widely reported that the force with which such airbags are deployed can cause injury to the very persons such bags are thought to protect. The force of deployment is especially detrimental to children and other small persons below a certain weight. A sensor used in combination with the airbag that could record, interpret and transmit signals to the airbag release mechanism related to the weight of the occupant currently in the car seat would be highly advantageous. In a sophisticated airbag release system, the rate and degree of inflation could be adjusted to occur in safe proportion to the weight of the seat occupant so as to reduce the degree of potential injury due to high velocity deployment. Document DE 38 39 134 C shows a sensor embedded in a vehicle seat.

Brief Description of the Invention

[0003] Briefly stated, and in accordance with a presently preferred embodiment of the invention, a sensor embedded in a vehicle seat for determining the nature of a person or object occupying the seat includes a layer of compressible material having a plurality of apertures extending therethrough from a first surface to a second surface of the layer, a first layer of conductive fabric on a first surface, a second layer of conductive fabric on a second surface, and a sensor connected to the first and second layers of conductive fabric for measuring the electrical resistance therebetween for determining the nature of a person or object occupying the seat.

[0004] In accordance with another aspect of the invention, the layer of conductive fabric is stretchable in one direction.

[0005] In accordance with still another aspect of the invention, a layer of conductive fabric is stretchable in two directions.

[0006] In accordance with a further aspect of the invention, one of the layers of conductive fabric has a higher resistivity measured in ohms per square than the other layer of conductive fabric, and a sensor is connected between spaced apart points on the higher resistivity layer of conductive fabric for measuring the resistance between the spaced apart points.

[0007] While the novel aspects of the invention are set forth with particularity in the appended claims, the invention itself, together with other objects and advantages thereof may be more readily comprehended by reference to the following detailed description of a presently preferred embodiment thereof, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a top plan view of a seat sensor in accordance with a presently preferred embodiment of the invention;
Figure 2 is a section taken along lines 2-2 of Figure 1;
Figure 3 is a section view of the sensor pad of the invention in an uncompressed state;
Figure 4 is a section view of the sensor pad of the invention in a compressed state;
Figure 5 is a diagrammatic view of a seat sensor system in accordance with the invention, including a plurality of sensor pads having different characteristics;
Figure 6 is a diagrammatic view of an embodiment of the invention that relies on the capacitance change as a foam layer is compressed;
Figure 7 is a view of the sensor pad of Figure 6 with a weight being applied thereto;
Figure 7a is a section taken along the lines 7a-7a of Figure 7; and
Figure 8 is a plan view of an embodiment with localized shorting pads on one fabric layer.

Description of the Invention

[0008] According to the present invention, the system can function either as a switch or as a weight sensor or both. The operating range and/or function of the sensor depends upon the way the materials are cut, adhered, or interconnected and upon the relative stability of the surrounding support structure.

[0009] As shown in Figures 1 and 2, the basic preferred construction of the sensor is a five-layer laminate although any suitable layered structure may be suitable. In the preferred five-layer system the basic construction comprises the following elements: a first layer of conductive fabric 10; a layer of adhesive 12; a layer of compressible foam 14; a layer of adhesive 16; and a second layer of conductive fabric 18.

[0010] The preferred fabric can be conductive throughout or conductive on one side only, and may be stretchy and flexible in one direction, both directions (x and y) or in neither direction. The conductivity must be matched to the properties of the other materials to produce a trigger or sensing in the desired range of weight. If the fabric is conductive on one side only, then that side must be against the foam.

[0011] The preferred adhesive must be sufficiently strong to adhere the fabric to the foam throughout the

life of the sensor or switch. The adhesive must be applied to the foam prior to any holes being cut, so that where there is a hole in the foam, there will be no adhesive on the fabric, as shown in Figures 2 and 3.

[0012] The preferred foam thickness, compression set and mechanical configuration preferably determine the functionality of the sensor. The foam must withstand repeated compression and flexing cycles as would naturally attend seat usage.

[0013] The preferred switch construction relies on the size and spacing of openings in the foam over the functional range. For instance, using an ester based foam having a thickness of about 0.25 in. thick 2 pound foam with approximately 0.40 in. diameter holes or pores spaced on about 0.1 in. centers might provide a triggering effect at about 50 pounds per square foot. Removing some of the holes, changing hole diameters, changing the spacing or changing the foam properties will produce a new trigger point in terms of weight distribution measured as pounds per square foot. The trigger point will also be affected and manipulated by altering the stiffness of the support structure.

[0014] According to the present invention, as shown in Figure 4 in one preferred embodiment, the switch operation relies on the flexibility of the conductive fabric and the compressibility of the foam. In operation, the foam 14 must compress somewhat, and the fabric 10, 18 must extend into the holes in the foam. At some point, the upper and lower fabric will touch, producing a conductive pathway. The switch relies on the flexibility of the support structure (both top and bottom) to push the fabric into the holes in the foam far enough to make contact between the two pieces of fabric. For instance, if the switch is placed on a firm table top, it will not work, because the lower fabric surface will never raise up through the holes in the foam to come in contact with the other fabric surface.

[0015] In one preferred embodiment, as shown in Figures 6, 7, and 7a, the construction of the sensor of the present invention relies on the capacitance effects of the fabric/foam laminate. As the two conductive layers 10, 18 are brought closer together by pressure, the distance between the fabric will change and the capacitance of the assembly can be measured. The capacitance value can be calibrated to provide a weight value. This assembly requires a continuous foam surface 14 with no holes, so that the two fabric surfaces cannot touch one another.

[0016] Figure 5 shows an embodiment of the invention in which a plurality of sensors is provided on a vehicle seat for determining the nature of a package or a person occupying the seat. Each of the sensors 30, 32, and 34 is formed in any of the manners described in the application, and is positioned with respect to the seat, so as to be actuated by a person sitting on the seat or an object placed thereon. For example, the sensor 30 may be placed on the seat, the sensor 32 disposed in the center of the seat so that it would be actuated by a person sitting on the seat but not by a car seat whose rails would straddle sensor 32, and sensor 34 could be positioned on the seat back. In this way, by noting the signals produced or not produced by loads applied to the three sensors, the nature of the person or thing occupying the seat could be determined.

[0017] Figure 8 shows another embodiment of the invention. In this embodiment, the bottom fabric layer 18 is characterized by a measurable resistivity, such as 1-10 ohms per square, and the upper fabric layer 10 is selectively conductive, so that pressure must be applied in certain areas to create a short circuit between spaced apart locations on lower fabric area 18. This will allow the location of loads on the sensor to be determined without the need for a matrix of inputs and outputs. For example, a person occupying a seat would be expected to create pressure close to the center of the sensor, while a car seat having side rails would exert more pressure at the edges and less at the center. Center pad 40 covers a 3 x 3 array of squares, and even if short circuits were created covering all nine of the openings, only a relatively small change in resistance would take place. However, longer conductive pads 42 and 44 which cover a relatively smaller number of openings, but a longer distance would produce a greater change in resistance, which could readily be detected by known means.

[0018] It will, of course, be understood that the present invention has been described above purely by way of example, and modifications of detail can be made within the scope of the invention as defined in the claims.

Claims

1. A sensor embedded in a vehicle seat for determining the nature of a person or object occupying the seat comprising
   a layer of compressible material (14) having a first surface and a second surface, **characterised by**
   a first layer of conductive fabric (10) on the first surface;
   a second layer of conductive fabric (18) on the second surface;
   a detector connected to two points on the conductive fabric (10, 18) for monitoring the electrical resistance or capacitance therebetween for determining the nature of a person or object occupying the seat.

2. The sensor of claim 1 in which the layers of conductive fabric (10, 18) are stretchable in one direction.

3. The sensor of claim 1 in which the layers of conductive fabric (10, 18) are stretchable in two directions.

4. The sensor of any of claims 1 to 3 in which the first layer of conductive fabric (10) has a very low resistivity, measured in ohms per square.

5. The sensor of any of claims 1 to 3 in which the first layer of conductive fabric (10) has a relatively high resistivity, measured in ohms per square.

6. The sensor of any of claims 1 to 5 in which the first layer of conductive fabric (10) comprises a continuously conductive fabric.

7. The sensor of any of claims 1 to 5 in which the first layer of conductive fabric (10) comprises a locally conductive fabric layer having conductive regions and non-conductive regions.

8. The sensor of any preceding claim, wherein the layer of compressible material (14) having plurality of apertures leading between the first surface and the second surface, said detector being arranged to monitor resistance between points on different conductive fabric layers (10, 18).

9. A sensor according to any preceding claim, wherein the layer of compressible material (14) has a plurality of apertures extending therethrough; the first layer of conductive fabric (10) on the first surface has a first resistivity, close to zero;
the second layer of conductive fabric (18) on the second surface has a higher resistivity than the first layer; and
said detector is connected to spaced apart points on the second layer of conductive fabric (18) for measuring the resistance between the points and producing a signal corresponding to the measured resistance for indicating the nature of a person or object occupying the seat.

10. The sensor of claim 9 in which the first layer of conductive fabric (10, 18) comprises a plurality of spaced apart conductive patches separated by low conductivity regions.

11. The sensor of claim 10 in which the plurality of conductive patches overlies at least two apertures in the layer of compressible material (14).

12. A sensor according to any preceding claim, wherein: said layer of compressible material (14) is a dielectric layer, and ;said detector is connected to the first and second layers of conductive fabric (10, 18) for measuring the electrical capacitance therebetween for determining the nature of a person or object occupying the seat.

Patentansprüche

1. Sensor, der in einen Fahrzeugsitz eingebettet ist zur Bestimmung der Beschaffenheit einer Person oder eines Gegenstandes, die den Sitz einnehmen mit einer Schicht aus zusammendrückbarem Material (14) mit einer ersten Fläche und einer zweiten Fläche, **gekennzeichnet durch**
eine erste Schicht aus leitendem Stoffgewebe (10) auf der ersten Fläche;
eine zweite Schicht aus leitendem Stoffgewebe (18) auf der zweiten Fläche;
einen Detektor, der an zwei Punkte auf dem leitenden Stoffgewebe (10, 18) angeschlossen ist, um den elektrischen Widerstand oder die Kapazitanz dazwischen zu überwachen zur Bestimmung der Beschaffenheit einer Person oder eines Gegenstandes, die den Sitz einnehmen.

2. Sensor gemäß Anspruch 1, bei welchem die Schichten aus leitendem Stoffgewebe (10, 18) in eine Richtung dehnbar sind.

3. Sensor gemäß Anspruch 1, bei welchem die Schichten aus leitendem Stoffgewebe (10, 18) in zwei Richtungen dehnbar sind.

4. Sensor gemäß irgendeinem der Ansprüche 1 bis 3, bei welchem die erste Schicht aus leitendem Stoffgewebe (10) einen sehr niedrigen spezifischen elektrischen Widerstand, gemessen in Ohms pro Quadrat, aufweist.

5. Sensor gemäß irgendeinem der Ansprüche 1 bis 3, bei welchem die erste Schicht aus leitendem Stoffgewebe (10) einen relativ hohen spezifischen elektrischen Widerstand, gemessen in Ohms pro Quadrat, aufweist.

6. Sensor gemäß irgendeinem der Ansprüche 1 bis 5, bei welchem die erste Schicht aus leitendem Stoffgewebe (10) einen durchgehend leitenden Stoff aufweist.

7. Sensor gemäß irgendeinem der Ansprüche 1 bis 5, bei welchem die erste Schicht aus leitendem Stoffgewebe (10) eine örtlich leitende Stoffschicht mit leitenden Bereichen und nicht leitenden Bereichen umfasst.

8. Sensor gemäß irgendeinem vorherigen Anspruch, wobei die Schicht aus zusammendrückbarem Material (14) eine Vielzahl von Öffnungen aufweist, die von der ersten Fläche bis zur zweiten Fläche durchgehen, wobei der Detektor dafür angeordnet ist, den Widerstand zwischen Punkten auf verschiedenen leitenden Stoffschichten (10, 18) zu überwachen.

9. Sensor gemäß irgendeinem vorherigen Anspruch, wobei die Schicht aus zusammendrückbarem Material (14) eine Vielzahl von Öffnungen aufweist, die sich durch sie hindurch erstrecken;

wobei die erste Schicht aus leitendem Stoffgewebe (10) auf der ersten Fläche einen ersten spezifischen elektrischen Widerstand nahe Null aufweist;
wobei die zweite Schicht aus leitendem Stoffgewebe (18) auf der zweiten Fläche einen höheren spezifischen elektrischen Widerstand als die erste Schicht aufweist; und
wobei der Detektor an voneinander beabstandete Punkte auf der zweiten Schicht aus leitendem Stoffgewebe (18) angeschlossen ist, um den Widerstand zwischen den Punkten zu messen und ein Signal entsprechend dem gemessenen Widerstand zu erzeugen, um die Beschaffenheit einer Person oder eines Gegenstandes, die den Sitz einnehmen, anzuzeigen.

10. Sensor gemäß Anspruch 9, bei welchem die erste Schicht aus leitendem Stoffgewebe (10) eine Vielzahl von mit Abstand angeordneten, leitenden Feldern aufweist, die durch Bereiche mit niedriger Leitfähigkeit voneinander getrennt sind.

11. Sensor gemäß Anspruch 10, bei welchem die Vielzahl leitender Felder mindestens zwei Öffnungen in der Schicht aus zusammendrückbarem Material (14) abdeckt.

12. Sensor gemäß irgendeinem vorherigen Anspruch, wobei: die Schicht aus zusammendrückbarem Material (14) eine nicht leitende Schicht ist; wobei der Detektor an die erste und zweite Schicht aus leitendem Stoffgewebe (10, 18) angeschlossen ist, um die elektrische Kapazitanz dazwischen zu messen zur Bestimmung der Beschaffenheit einer Person oder eines Gegenstandes, die den Sitz einnehmen.

Revendications

1. Capteur inséré dans le siège d'un véhicule pour déterminer la nature d'une personne ou d'un objet occupant le siège, comprenant :

une couche de matériau compressible (14) comportant une première surface et une seconde surface,

caractérisé par

une première couche de tissu conducteur (10) sur la première surface;

une seconde couche de tissu conducteur (18) sur la seconde surface;

un détecteur connecté à deux points sur le tissu conducteur (10, 18) pour surveiller la résistance ou la capacité électrique entre eux pour déterminer la nature d'une personne ou d'un objet occupant le siège.

2. Capteur selon la revendication 1, dans lequel les couches de tissu conducteur (10, 18) sont extensibles dans une direction.

3. Capteur selon la revendication 1, dans lequel les couches de tissu conducteur (10, 18) sont extensibles dans deux directions.

4. Capteur selon l'une quelconque des revendications 1 à 3, dans lequel la première couche de tissu conducteur (10) a une très faible résistivité, mesurée en ohms par carré.

5. Capteur selon l'une des revendications 1 à 3, dans lequel la première couche de tissu conducteur (10) a une résistivité relativement élevée, mesurée en ohms par carré.

6. Capteur selon l'une des revendications 1 à 5, dans lequel la première couche de tissu conducteur (10) comprend un tissu continuellement conducteur.

7. Capteur selon l'une quelconque des revendications 1 à 5, dans lequel la première couche de tissu conducteur (10) comprend une couche de tissu localement conducteur comportant des régions conductrices et des régions non conductrices.

8. Capteur selon l'une quelconque des revendications précédentes, dans lequel la couche de matériau compressible (14) ayant une pluralité d'ouvertures mettant en communication la première surface et la seconde surface, ledit détecteur étant agencé pour surveiller la résistance entre des points sur des couches différentes (10, 18) de tissu conducteur.

9. Capteur selon l'une quelconque des revendications précédentes, dans lequel :

la couche de matériau compressible (14) a une pluralité d'ouvertures s'étendant à travers celui-ci;
la première couche de tissu conducteur (10) sur la première surface a une première résistivité voisine de zéro;
la seconde couche de tissu conducteur (18) sur la seconde surface a une résistivité plus élevée que la première couche; et
ledit détecteur est connecté à des points écartés sur la seconde couche de tissu conducteur (18) pour mesurer la résistance entre les poins et produire un signal correspondant à la résistance mesurée pour indiquer la nature de la personne ou de l'objet occupant le siège.

10. Capteur selon la revendication 9, dans lequel la première couche de tissu conducteur (10, 18) comprend une pluralité de zones conductrices écartées

séparées par des régions de faible conductivité.

11. Capteur selon la revendication 10, dans lequel la pluralité de zones conductrices écartées recouvrent au moins deux ouvertures dans la couche de matériau compressible (14).

12. Capteur selon l'une quelconque des revendications précédentes, dans lequel :

ladite couche de matériau compressible (14) est une couche diélectrique; et
ledit détecteur est connecté aux première et seconde couches de tissu conducteur (10, 18) pour mesurer la capacité électrique entre elles pour déterminer la nature de la personne ou de l'objet occupant le siège..

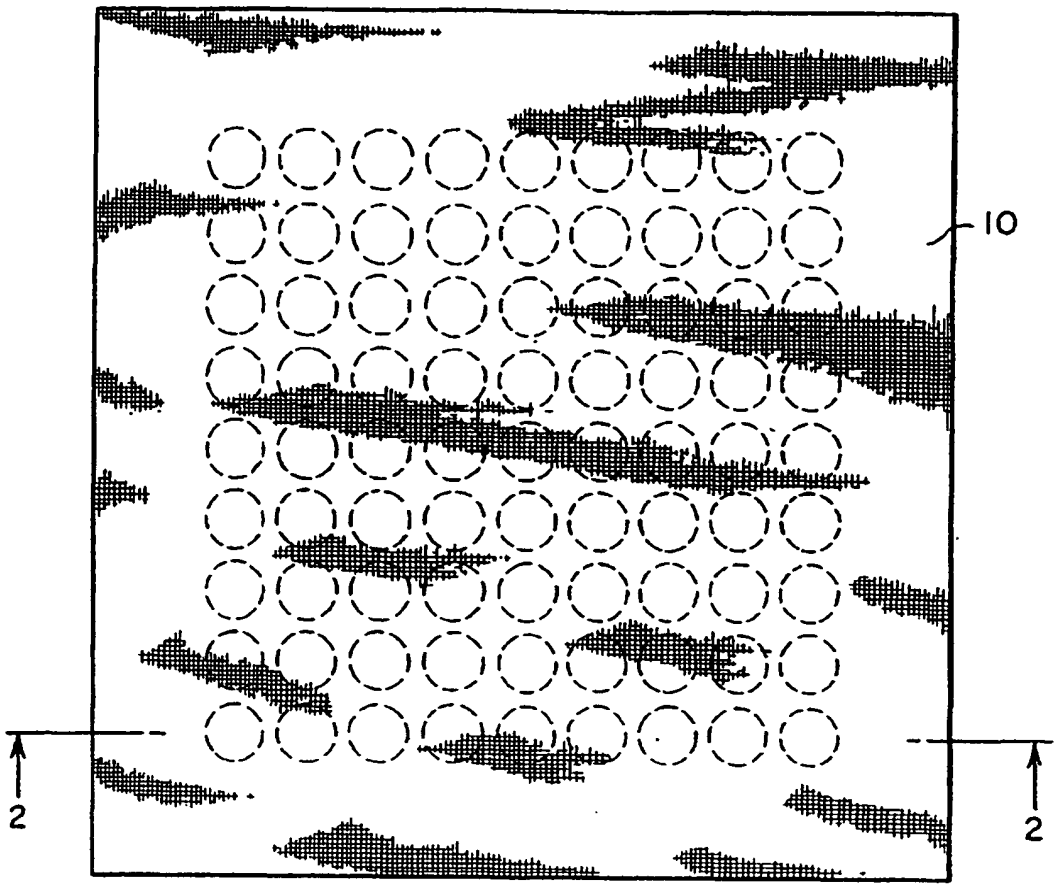

FIG. 1

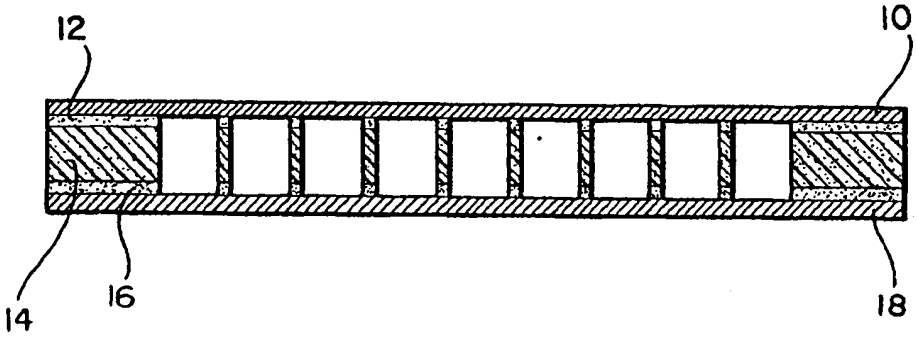

FIG. 2

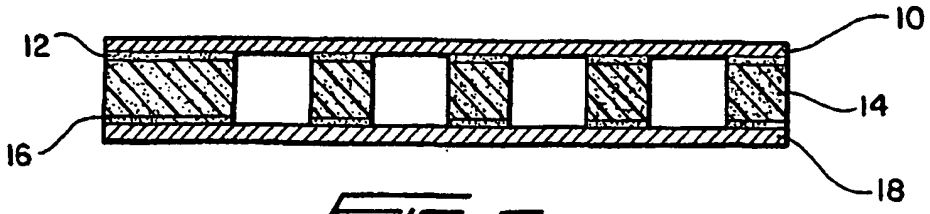

FIG. 3

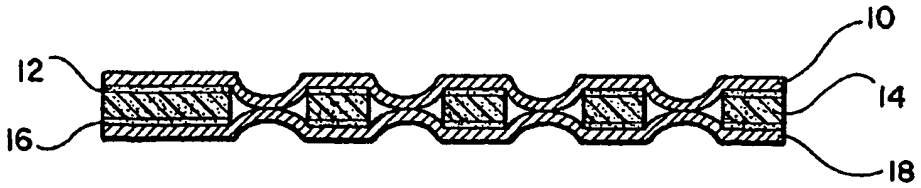

FIG. 4

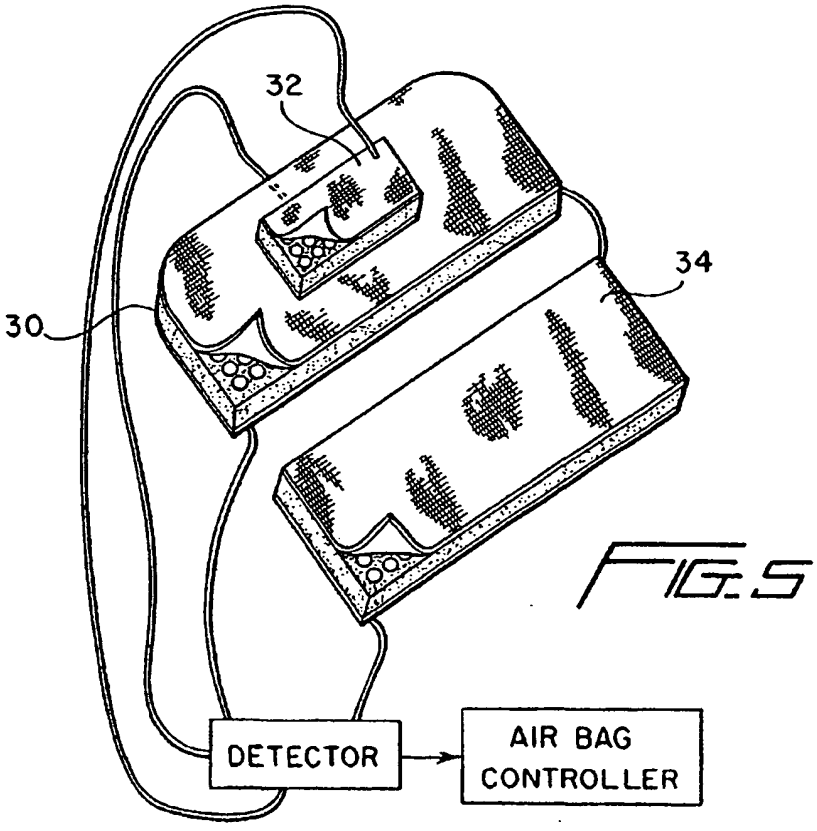

FIG. 5

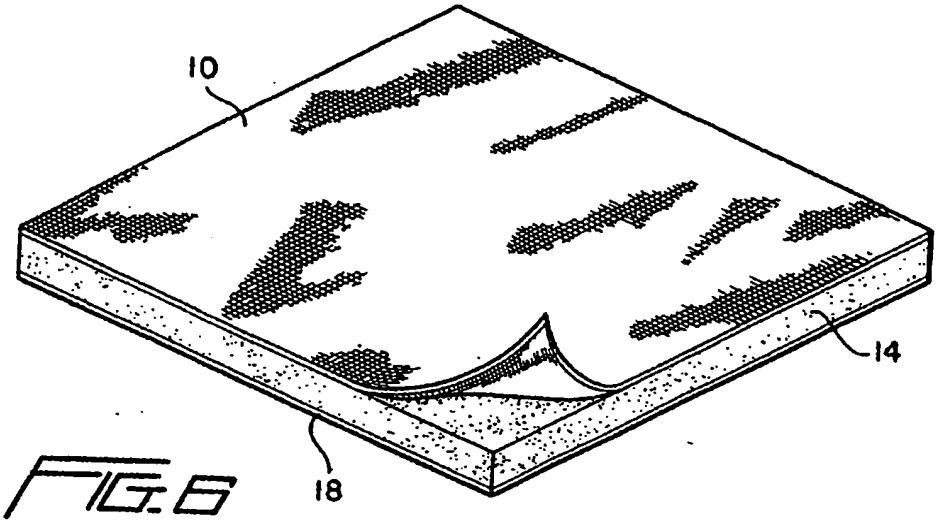

FIG. 6

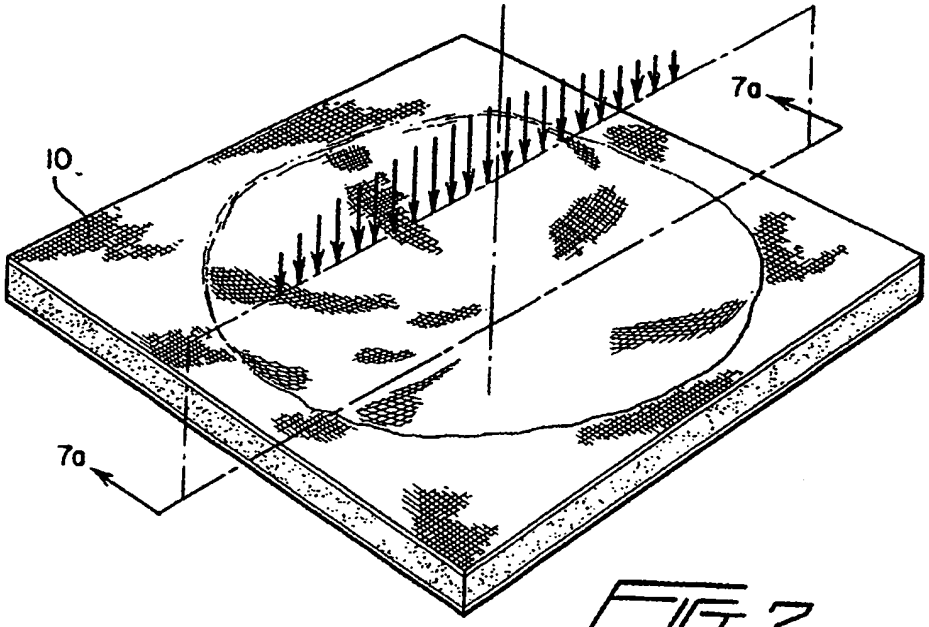

FIG. 7

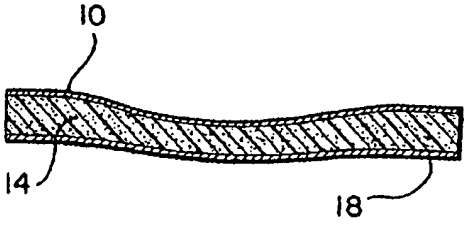

FIG. 7a

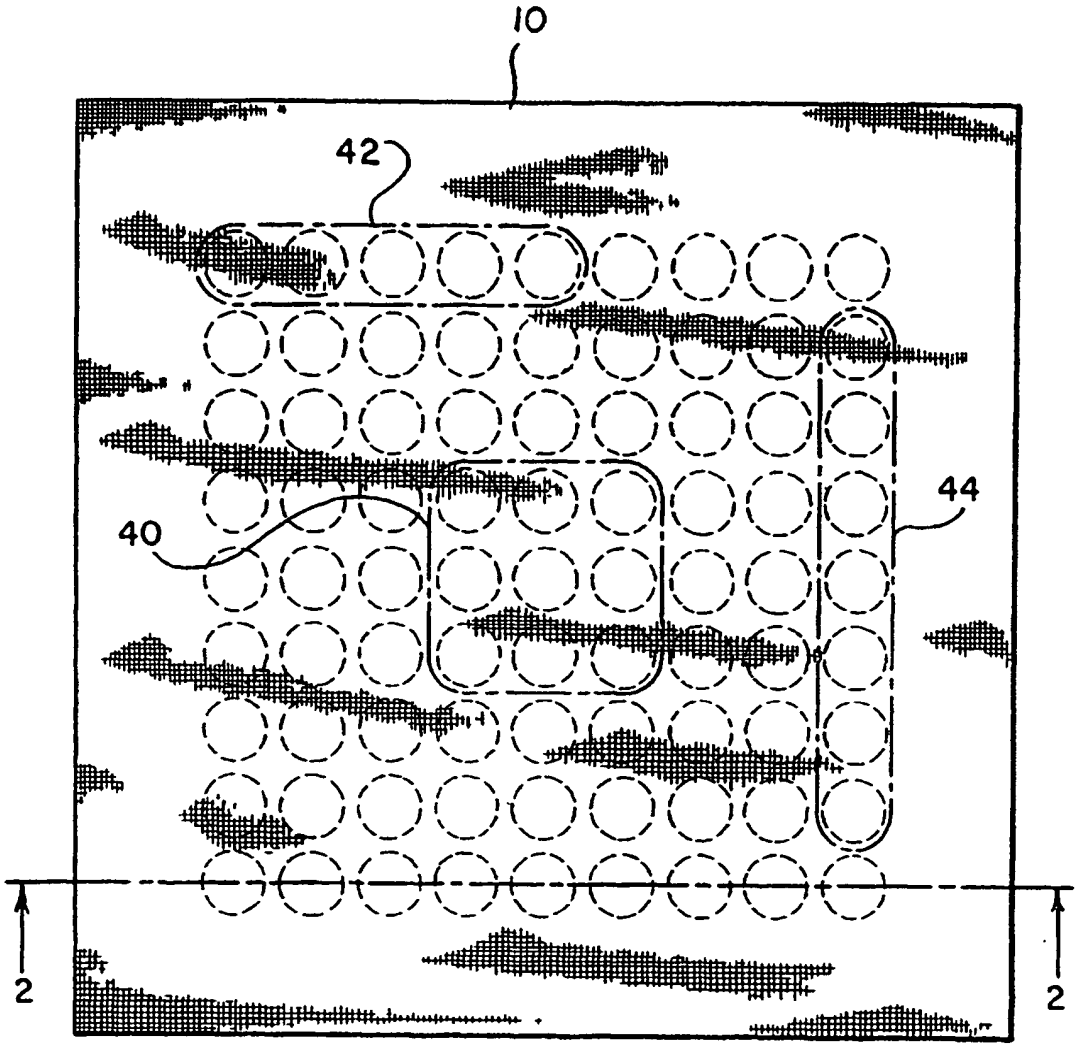

FIG. 8